# 1. PUBLIC HEALTH STATEMENT

This Statement was prepared to give you information about plutonium and to emphasize the human health effects that may result from exposure to it. The Environmental Protection Agency (EPA) has identified 1.177 sites on its National Priorities List (NPL). Plutonium has been found above background levels at five of these sites. However, we do not know how many of the 1,177 NPL sites have been evaluated for plutonium. As EPA evaluates more sites, the number of sites at which plutonium is found may change. The information is important for you because plutonium may cause harmful health effects and because these sites are potential or actual sources of human exposure to plutonium.

When a radioactive chemical is released from a large area such as an industrial plant, or from a container such as a drum or bottle, it enters the environment as a radioactive chemical. This emission, which is also called a release, does not always lead to exposure. You can be exposed to a chemical only when you come into contact with the chemical. You may be exposed to it in the environment by breathing, eating, or drinking substances containing the chemical or from skin contact with it.

If you are exposed to a hazardous substance such as plutonium, several factors will determine whether harmful health effects will occur and what the type and severity of those health effects will be. These factors include the dose (how much), the duration (how long), the route or pathway by which you are exposed (breathing, eating, drinking, or skin contact), the other chemicals to which you are exposed, and your individual characteristics such as age, sex, nutritional status, family traits, life style, and state of health.

## 1.1 WHAT IS PLUTONIUM?

Plutonium is a silvery-white radioactive metal that exists as a solid under normal conditions. It is produced when uranium absorbs an atomic particle. Small amounts of plutonium occur naturally, but large amounts have been produced by man in nuclear reactors. Plutonium can be found in the environment in several forms called isotopes. The most common plutonium isotopes are plutonium-238 and plutonium-239. Because plutonium is a radioactive element, it constantly changes or "decays." In this decay process, energy is released and a new product is formed. The energy released is called radiation. When plutonium decays, it divides into two parts -- a small part that we call "alpha" radiation and the remainder, different from original plutonium, called the daughter. The daughter is also radioactive, and it, too, continues to decay until a nonradioactive daughter is formed. During these decay processes, alpha, beta, and gamma radiation are released. Alpha particles can travel only very short distances and cannot go through the

thickness of your skin. Beta particles can travel farther and can penetrate a few millimeters into your tissues. Gamma radiation travels the farthest and can go all the way through your body. It takes about 90 years for one-half of a quantity of plutonium-238 to break down to its daughter and about 24,000 years for this to happen to plutonium-239.

Plutonium-238 is used to provide on board power for electronic systems in satellites. Plutonium-239 is used primarily in nuclear weapons. Most plutonium is found combined with other substances, for example, plutonium dioxide (plutonium with oxygen) or plutonium nitrate (plutonium with nitrogen and oxygen). More information about the properties and uses of plutonium can be found in Chapters 3, 4, and 5.

## 1.2 HOW MIGHT I BE EXPOSED TO PLUTONIUM?

Plutonium has been released to the environment primarily by atmospheric testing of nuclear weapons and by accidents at weapons production and utilization facilities. In addition, accidents involving weapons transport, satellite reentry, and nuclear reactors have also released smaller amounts of plutonium into the atmosphere. When plutonium was released to the atmosphere, it returned to the earth's surface as fallout. Average fallout levels in soils in the United States are about 2 millicuries (mCi)/square kilometer (about 0.4 square miles) for plutonium-239 and 0.05 mCi/square kilometer for plutonium-238. A millicurie is a unit used to measure the amount of radioactivity; 1 mCi of plutonium-239 weighs 0.016 gm, while 1 mCi of plutonium-238 weighs 0.00006 gm. Measurements in air have been made at a few locations. For example, air levels of plutonium-239 in New York City in the 1970s were reported to be 0.00003 picocuries (pCi) per cubic meter of air. One pCi is one billionth of a mCi. Persons who work at nuclear plants using plutonium have a greater chance of being exposed than individuals in the general population. However, you could be exposed to plutonium if there was an accidental release of plutonium during use, transport, or disposal. Because plutonium does not release very much gamma radiation, harmful health effects are not likely to occur from being near plutonium unless you breathe or swallow it. You may find more information about exposure to plutonium in Chapter 5.

## 1.3 HOW CAN PLUTONIUM ENTER AND LEAVE MY BODY?

You are most likely to be exposed to plutonium by breathing it in. Once breathed in, the amount that stays in the lungs depends upon several things, particularly the particle size and form of the plutonium compound breathed in. The forms that dissolve easily may be absorbed (pass through the lungs into other parts of the body) or some may remain in the lung. The forms that dissolve less easily are often coughed up and then swallowed. However, some of these may also remain in the lung. Plutonium taken in with food or water is poorly absorbed from the stomach, so most of it leaves the body in feces. Absorption of

plutonium through undamaged skin is very limited, but it may enter the body through wounds.

Some of the plutonium absorbed into the body leaves the body in urine. The rate of plutonium removal from the tissues of the body is very slow, however, occurring over years. Most of the plutonium that stays in the body is found in the lungs, liver, and sireleton. You may find more information about this subject in Chapter 2.

## 1.4 HOW CAN PLUTONIUM AFFECT MY HEALTH?

Plutonium may remain in the lungs or move to the bones, liver, or other body organs. It generally stays in the body for decades and continues to expose the surrounding tissues to radiation. This may eventually increase your chance of developing cancer, but it would be several years before such cancer effects became apparent. The experimental evidence is inconclusive, and studies of some human populations who have been exposed to low levels of plutonium have not definitely shown an increase in cancer. However, plutonium has been shown to cause both cancers and other damage in laboratory animals, and might affect the ability to resist disease (immune system). We do not know if plutonium causes birth defects or affects the ability to have children. However, radioactivity from other radioactive compounds can produce these effects. If plutonium can reach these sensitive target tissues, radioactivity from plutonium may produce these effects. More information on the health effects of plutonium is presented in Chapter 2.

## 1.5 WHAT LEVELS OF EXPOSURE HAVE RESULTED IN HARMFUL HEALTH EFFECTS?

Plutonium is odorless and tasteless so you cannot tell if you are being exposed to plutonium. If you breathe in plutonium, some of it will be retained in your body. When discussing harmful health effects, the amount of plutonium that caused these effects is usually given as the amount of plutonium retained or deposited in the body rather than as the amount that was in the air. As indicated in Tables l-l through 1-4, there is no information from studies in humans or animals to identify the specific levels of exposures to plutonium in air, food, or water that have resulted in harmful effects. However, it is generally assumed that any amount of absorbed radiation, no matter how small, may cause some damage. When expressed as the amount of radioactivity deposited in the body per kilogram of body weight (kg bw) as a result of breathing in plutonium, studies in dogs report that 100,000 pCi plutonium/kg bw caused serious lung damage within a few months, 1,700 pCi/kg bw caused harm to the immune system, and 1,400 pCi/kg bw caused bone cancer after 4 years. In each of these cases the dogs were exposed to the plutonium

**TABLE 1-1. Human Health Effects from Breathing Plutonium***

| Short-term Exposure (less than or equal to 14 days) | | |
|---|---|---|
| Levels in Air | Length of Exposure | Description of Effects |
| | | The health effects resulting from short-term exposure of humans breathing specific levels of plutonium are not known. |
| **Long-term Exposure (greater than 14 days)** | | |
| Levels in Air | Length of Exposure | Description of Effects |
| | | The health effects resulting from long-term exposure of humans breathing specific levels of plutonium are not known. |

*See Section 1.2 for a discussion of exposures encountered in daily life.

**TABLE 1-2. Animal Health Effects from Breathing Plutonium**

| Short-term Exposure (less than or equal to 14 days) | | |
|---|---|---|
| Levels in Air | Length of Exposure | Description of Effects |
| | | The health effects resulting from short-term exposure of animals breathing specific levels of plutonium are not known. |
| **Long-term Exposure (greater than 14 days)** | | |
| Levels in Air | Length of Exposure | Description of Effects |
| | | The health effects resulting from long-term exposure of animals breathing specific levels of plutonium are not known. |

**TABLE 1-3. Human Health Effects from Eating or Drinking Plutonium***

| Short-term Exposure (less than or equal to 14 days) | | |
|---|---|---|
| Levels in Food | Length of Exposure | Description of Effects |
| | | The health effects resulting from short-term exposure of humans to food containing specific levels of plutonium are not known. |
| Levels in Water | | |
| | | The health effects resulting from short-term exposure of humans to water containing specific levels of plutonium are not known. |
| **Long-term Exposure (greater than 14 days)** | | |
| Levels in Food | Length of Exposure | Description of Effects |
| | | The health effects resulting from long-term exposure of humans to food containing specific levels of plutonium are not known. |
| Levels in Water | | |
| | | The health effects resulting from long-term exposure of humans to water containing specific levels of plutonium are not known. |

*See Section 1.2 for a discussion of exposures encountered in daily life.

TABLE 1-4. Animal Health Effects from Eating or Drinking Plutonium

| Short-term Exposure (less than or equal to 14 days) | | |
|---|---|---|
| Levels in Food | Length of Exposure | Description of Effects |
| | | The health effects resulting from short-term exposure of animals to food containing specific levels of plutonium are not known. |
| Levels in Water | | The health effects resulting from short-term exposure of animals to water containing specific levels of plutonium are not known. |
| **Long-term Exposure (greater than 14 days)** | | |
| Levels in Food | Length of Exposure | Description of Effects |
| | | The health effects resulting from long-term exposure of animals to food containing specific levels of plutonium are not known. |
| Levels in Water | | The health effects resulting from long-term exposure of animals to water containing specific levels of plutonium are not known. |

in air for one day. You can find more information on the health effects of plutonium in Chapter 2.

## 1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I RAVE BEEN EXPOSED TO PLUTONIUM?

There are tests available that can reliably measure the amount of plutonium in a urine sample even at very low levels. These measurements can be used to estimate the total amount of plutonium that is carried by the body. However, these measurements cannot be used to directly determine the levels to which the person was exposed or to predict the potential for health effects. In addition, there are tests to measure plutonium in soft tissues (such as body organs), feces, bones, and milk. These tests are not routinely available in your doctor's office because special laboratory equipment is required. You can find more information on methods used to measure levels of plutonium in Chapters 2 and 6.

## 1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

Guidelines for radiation protection have been established for the general public and for occupational settings. These guidelines are expressed in units called rems. A rem is a unit that measures the amount of radiation absorbed by the body. For people in the general population, national guidelines recommend dose limits of 0.5 rems/year, while international guidelines set dose limits of 0.5 rems/year for short-term exposure and 0.1 rems/year for long-term exposure. For workers in industries where exposure to radiation may occur, the EPA has recommended a dose limit of 5 rems/year. This is the same dose limit set for workers by the International Commission on Radiological Protection (ICRP). The ICRP has developed limits for the amount of radioactivity we take into the body, called Annual Limits on Intake (ALIs), and for the amount of radioactivity in the air we breathe, called Derived Air Concentrations (DACS). For workers exposed to plutonium-239 in air, the AL1 is 20,000 pCi/year and the DAC is 7 pCi/$m^3$ of air. The ALIs and DACs vary with each plutonium isotope. You may find more information on regulations and guidelines in Chapter 7.

## 1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns not covered here, please contact your State Health or Environmental Department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road, E-29
Atlanta, Georgia 30333

This agency can also give you information on the location of the nearest occupational and environmental health clinics. Such clinics specialize in recognizing, evaluating, and treating illnesses that result from exposure to hazardous substances.